Appendix A

Streamflow Tools

Introduction

This appendix describes tools that should be provided in DDAP to check, compare, modify and adjust streamflow data. The tools are not dependent on a particular PETA or whether one is working with the historical POR or an extension, i.e. the procedure doesn't change from one PETA or period to another.

Basic Display

The display that is shown in the window that appears when this category of tools is selected should include the following:

- Basin boundaries - i.e. the overall boundaries of the Basin currently selected as specified in the Basin definition (not Watershed boundaries),

- Rivers and streams (other overlays could be selected by the user), and

- Locations of all points within the Basin boundaries that have observed historical streamflow data as specified in the meta data files for enhanced calibration system (use different colors or symbols to differentiate between daily data, daily and instantaneous data, and monthly volumes - query function can be used to get further information about each location).

Menus

Control and Tools menus should be included. The Control menu only needs a Quit option. The Tools menu should contain the following streamflow analysis options (each described on a separate page):

1. Local Area Flow Computation,
2. Streamflow Adjustment,
3. Daily Flow from Monthly Volumes,
4. Streamflow Consistency Check, and
5. Streamflow Comparison.

Each of these analysis options would produce additional windows for the user to enter input and to display results.

Local Area Flow Computation

Function: Computes local area flow by subtracting routed upstream flows from downstream values.

User Specification:

- Downstream location and Δt,
- Upstream locations (must have same Δt as downstream site),
- Period of record (default to longest period when all locations have data), and
- Simple Tatum routing coefficients for each upstream location based on Δt of data (sums should be less than or equal to 1.0 for each - warning should be issued if coefficients don't sum to 1.0 - could sum to less than 1.0 if a loss in the reach).

Method:

- Route each upstream flow using simple Tatum routing (no layers - a single coefficient of 1.0 indicates no routing) and subtract from downstream flow,
- Resulting difference cannot be negative - if less than zero, set to zero, and if any value is missing for a given time interval, the result should be missing for that interval, and
- User can change routing coefficients and re-run.

Display Generated:

- Two time series plots in the same window, one above the other. The top plot would show the downstream flow, each upstream routed flow, and the total routed flow. The lower plot would show the difference or local flow. A option should be provided to toggle back and forth between an arithmetic and semi-log scale (arithmetic scale in discharge units and semi-log scale in runoff depth).

Output: (if user Okays the results)

- Time series of local area flows, and
- Expand meta data record at the downstream location to reflect that the location now has generated local area streamflow data (the expanded record should include among other information the local drainage area, upstream identifiers, and routing coefficients)

Streamflow Adjustments

Function: Adjusts streamflow data at a given location for diversions, etc. by adding or subtracting one or more time series from the observed values.

Basic Display Modification:

- Expand the display to show which locations have estimated daily streamflow values - i.e. sites for which the Daily Flow from Monthly Volume tool described in this appendix has been run (don't include those with generated local area flows or adjusted flows)

User Specification:

- Location and Δt,
- Locations to be added or subtracted from base location (indicate if to be added or subtracted - Δt must be the same as for the base location), and
- Period of record (default to longest period when all locations have data).

Method:

- Add or subtract each diversion location from the flow at the base location,
- Result cannot be negative - if less than zero, set to zero, and if any value is missing for a given time interval, the result should be missing for that interval.

Display Generated:

- Two time series plots in the same window, one above the other. The top plot would show the flow at the base location and each diversion. The lower plot would show the adjusted flow at the base location. A option should be provided to toggle back and forth between an arithmetic and semi-log scale (arithmetic scale in discharge units and semi-log scale in runoff depth).

Output: (if user Okays the results)

- Time series of adjusted flows, and
- Expand meta data record to reflect that the location now has adjusted streamflow data (the expanded record should include among other information the time series used to adjust the flow record).

Daily Flow from Monthly Volumes

Function: Produces a daily flow time series from monthly volume data. Only monthly volume data may be available for diversions that are needed to adjust river locations to natural flow conditions.

User Specification:

- Location,
- Period of record (defaults to the entire period with observed monthly volumes).

Method and Display: One possible simple procedure is as follows (better methods could likely be devised):

- Set the daily value at the end of each month to the average of the mean flow for that month and the next month (if the volume for either month is missing, set the value to the mean flow for the non-missing month),
- Compute a flow for the middle of each month with non-missing data that would produce the correct monthly volume using linear interpolation between the end of month and mid month points,
- Plot resulting daily flows with the end of month values highlighted - some values can be negative at this point (if volume missing for a month, all the daily flows are set to missing),
- Allow user to interactively move end of month points up or down to improve daily flow variation and remove negative values - automatically adjust middle of month points to preserve the monthly volume (months with negative values must be corrected).

Output: (if user Okays the results)

- Time series of computed daily flows, and
- Expand meta data record to reflect that the location now has estimated daily flows computed from monthly volumes.

Streamflow Consistency Check

Function: Perform a double mass analysis on daily streamflow records to look for inconsistencies caused by factors such as changes in diversions or flow regulation over time, physical modifications due to urbanization, agricultural practices, forest fires, alterations in vegetation cover, etc., or rating problems.

User Specification:

- New consistency check or Re-run check for a previously defined group of stations.
- If a New check:
  - Unique identifier for consistency check group,
  - Locations to be included,
  - Daily flow time series to use at each location (observed, adjusted, total drainage or local area),
  - Whether each time series is to be included in computing the group base (yes or no),
  - Period of record (default to period that all sites have data values),
  - Station to use as the base for estimating missing monthly runoff volumes, and
  - How to group stations on display (max of 5 stations per plot).
- If a previously defined consistency check group:
  - Identifier of group (chose from a list of previously defined groups),
  - Stations to be added or subtracted from the group, and
  - Period of record (defaults to period when group last run).
- Both cases:
  - Consistency corrections to enter before running or re-running the check (interactive input of correction dates and base slope and then automatic computation of correction).

Method: Double mass analysis as basically described in Section 6-6 of the Calibration Manual. Use monthly runoff volumes computed from daily flow data. Estimate missing months using the ratio to base station method utilized by PXPP for precipitation.

Display Generated:

- Graphical consistency plot similar to precipitation consistency plot in IDMA (max of 5 stations per plot), and
- Estimated data periods should be in a different color so they can clearly be identified.

Output: (If user Okays the results)

- Adjusted time series for any stations that were corrected for inconsistencies,
- Expand meta data record to reflect that the location now has an adjusted time series due to an inconsistency in the record (the expanded record should include among other information the consistency corrections applied and their corresponding periods of record), and
- Information needed to re-run the consistency check for this group of stations at a later time (to be referenced by the Basin and the group identifier).

Streamflow Comparison

Function: Compare daily streamflow records for various locations within the Basin. Basic comparison procedure is described under "Integrated Analysis of Hydrologic Conditions" in Chapter 4 of the Calibration Manual. Comparison can be done using MCP/ICP, however, could be more automated if added to DDAP.

User Specification:

- New comparison or Re-run a comparison for a previously defined group of stations.
- If a New comparison:
  - Unique identifier for streamflow comparsion group,
  - Locations to be included,
  - Daily flow time series for each location (observed, adjusted, total or local area),
  - Indicator to adjust to a common drainage area (if 'on', specify the base location),
  - Indicator to adjust to a common annual runoff amount (if 'on', specify the base location if not chosen previously), and
  - Period of record (default covers the period of record for all specified locations).
- If a previously defined consistency check group:
  - Identifier of group (chose from a list of previously defined groups),
  - Period of record (defaults to period when group last run),
  - Stations to be added or subtracted from the group, and
  - Ability to change common drainage area and annual runoff options.

Method:

- Adjustment to a common drainage area is done by multiplying all daily flows by the ratio of the area of the base location to the area of the current location, and
- Adjustment to a common annual runoff is by multiplying all daily flows by the ratio of the runoff for the base location to the runoff for the current location (ratio is computed from all months when both locations have complete data - for this option each location must have data for a period that overlaps with the base location).

Display Generated:

- Daily flow time series all on a common plot (like WY-PLOT display in ICP),
- If all locations are adjusted to a common drainage area and/or annual runoff, the default should be a semi-log scale. If no adjustment, the default should be a arithmetic scale. A option should be provided to toggle back and forth between an arithmetic and semi-log scale (arithmetic scale in discharge units and semi-log scale in runoff depth - when switching to a semi-log scale when there is no adjustment, the drainage area of each location should be used to generate depth of runoff values).

Output: (If user Okays the results)

- Information needed to re-run the streamflow comparison for this group of stations at a later time (to be referenced by the Basin and the group identifier).